Climate Change Impact on Water and Food: 
The Role of the Water Energy Food Nexus

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Outline

1. Situational Analysis and projections for water, energy, food and impact of human migration in Lebanon
2. Climate Change Regional Overview and impact on water, energy, food and infrastructure
3. Framework for climate adaptation and resilience
4. Role of WEF Nexus in addressing the primary resources security under Climate Change
5. Lessons learned from other similar regions
6. WEFRAH initiative
7. Closing comments
Challenge of Today’s Water Allocation Model & Interconnected Primary Resources

**Energy**
- +80% by 2050

**Water**
- +55% by 2050
  - 80% of freshwater used by agriculture sector
  - 15% of global freshwater withdrawals for energy production
  - 30% of world energy consumed by food sector

**Food**
- +60% by 2050

**New Business Model is Needed**

**BASED ON VALUES**

**Challenges**
1. Inter-dependencies
2. Inequity
3. Distribution
4. Allocative model


**Population**
- 9 billion population by 2050

**Region**
- 10-30% less precipitation than in 1980-1999 in most sub-tropical regions (IPCC)
Status of the Water and Sanitation in Lebanon as of 2015

Status on Access to Safely Managed Drinking-Water Services

- Percentage of the total population having access to at least basic drinking water services: 92%
- Proportion of population having access to safely managed water drinking services (free from contamination): 47%

Status of Access to Safely Managed Sanitation Services

- Percentage of the total population having access to at least basic sanitation services: 95%
- Proportion of population having access to safely managed sanitation services: 20%

Ministry of Energy and Water, Lebanon
Human Migration in Lebanon

The Countries With the Most Refugees Per Capita

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Refugees per 1,000 inhabitants in 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lebanon</td>
<td>232</td>
</tr>
<tr>
<td>Jordan</td>
<td>87</td>
</tr>
<tr>
<td>Nauru</td>
<td>39</td>
</tr>
<tr>
<td>Chad</td>
<td>34</td>
</tr>
<tr>
<td>Djibouti</td>
<td>23</td>
</tr>
<tr>
<td>South Sudan</td>
<td>21</td>
</tr>
<tr>
<td>Turkey</td>
<td>21</td>
</tr>
<tr>
<td>Mauritania</td>
<td>19</td>
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<tr>
<td>Sweden</td>
<td>15</td>
</tr>
<tr>
<td>Malta</td>
<td>14</td>
</tr>
</tbody>
</table>

Distribution of Refugees in Lebanon in Numbers

[Map showing distribution of Syrian refugees in Lebanon with different shaded areas representing different percentages of households with moderate to severe food insecurity.]

Source: UNHCR
Coastal Cities where Annual Average Losses Increase due Sea Level Rise in 2050

Impact of Climate Change on Streamflow and Hydropower: Projections are for Altered River Flow

- Surface and subsurface water resources are affected: River flow reduction impacts water supply; Stream flow reduction impacts soil moisture availability.
- This negatively impacts:
  - Food production and adds pressure to compensate through irrigation to maintain production
  - Hydropower generation potential in some ESCWA countries where hydropower plays a role in energy portfolio
- This impact is not quantified, but must be included in future studies of the impact of climate change on water and energy nexus

Reduction in availability of groundwater recharge in the bulk of the ESCWA region (most dramatic in subtropics)

What you see is non-stationarity: the future is not like the past

Less water in Lebanon region

Impacts of Climate Change and Natural Disasters on Food Security

Agricultural output will decrease 21% by 2080, with peaks of an almost 40% decrease in countries like Algeria and Morocco.

Other Impacts Climate Change and Natural Disasters

- Dust storms frequency and intensity
- Changing agricultural zones and water management
- Human mobility

UN-ESCWA (2016). Developing the Capacity of ESCWA Member Countries to Address the Water and Energy Nexus for Achieving Sustainable Development Goals, Regional Policy Toolkit
Activities that impact development, regardless of climate change impacts, For example, activities that target: Poverty, Literacy, Gender, Pollution

Target the strengthening and/or building of institutions
Includes technological approaches and tools
Examples of measures are Reforestation to combat landslides, Integrate resource management systems, Weather monitoring stations

Implementation of activities that can decrease the risk of certain climate change events
For example, Drought resistant crops, Climate proofing, Development of disaster response programs

Measures that aim at alleviating the effects of climate events
For example, Relocation of communities, Repairs of damaged infrastructure

UN-ESCWA (2016). Developing the Capacity of ESCWA Member Countries to Address the Water and Energy Nexus for Achieving Sustainable Development Goals, Regional Policy Toolkit
Defining the Water – Energy – Food Nexus


WEF Framework

Rain and Climate Variability

Average Annual Precipitation

Texas

North Africa / Middle East, Mean Annual Precipitation (mm)

Legend (in inches):
- Less than 14
- 14 to 18
- 18 to 22
- 22 to 26
- 26 to 30
- 30 to 34
- Above 34

This map is a plot of 1961-1990 annual average precipitation contours from NOAA
Cooperative stations and (where appropriate) USDA-NRCS SNOTEL stations. Christopher
Dyson used the PRISM model to generate the gridded estimates from which this map was
developed; the modeled grid was approximately 4 km; latitude/longitude; and was resampled
to 20 km using a Gaussian filter. Mapping was performed by Jason Wedburg. Funding was
provided by USDA-NRCS National Water and Climate Center.

WEF Nexus Research Group
Impact of WEF Nexus Approach

Quantify the interrelations and trade-offs between the water, energy, and transportation sectors under different scenarios:
1. Increasing (or decreasing) production
2. Changes in oil and gas market price
3. Different lateral lengths
4. Amount of reused water
5. Varying modes of transport for water/oil/gas

Annual income could increase by as much as $32 million over the current “business as usual” mainly addressing the agricultural sector, which currently suffering from lack of water.

EPAT shows that the CPP policy succeeds in mitigating the carbon emissions by sustaining same level even after capacity increase, and in decreasing the water withdrawal volumes in generation by 35%. On the other hand, the CPP policy increases water consumption by 5%, land use by 143% and cost by 18%.

Energy Portfolio Assessment Tool (EPAT)

Matagorda County, Texas

Montar & Bassel Daher (2016): Water-Energy-Food Nexus

Mohtar & Bassel Daher (2016): Water-Energy-Food Nexus
Water – Energy – Food – Health Nexus: Renewable Resources Initiative (WEFRAH)

**Goals**

1. Understand complexities,
2. Reduce interdependencies
3. Increase resilience

[http://www.aub.edu.lb/fafs/wefrah/Pages/default.aspx](http://www.aub.edu.lb/fafs/wefrah/Pages/default.aspx)
Key Messages

1. Climate change impact on water, energy & food are significant; a nexus multi-stakeholders / scale approach is needed.

2. WEF Nexus Tools are useful to assess economic, social & environmental sustainability of technologies or policies.

3. Account for the spatial and temporal attributes of resources and for hotspots of resource demand

4. Build capacity across public, private, academic, utilities, farmers, operators, and consumers

5. Integrated approaches can be achieved through creation of regional cooperation & community of practice
Thank You